Linac-ring.
Beam dynamics issues.

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Issues

- Electron polarization
- Beam-beam
- Instabilities

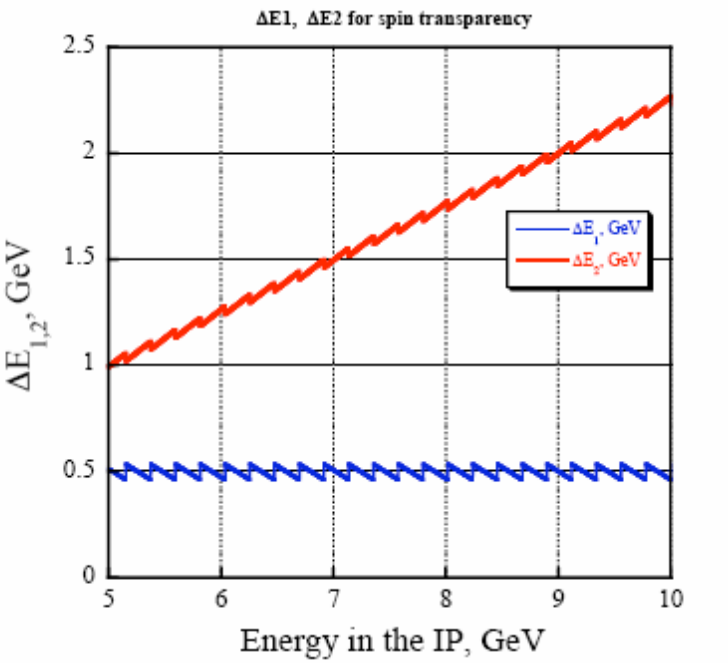
Electron polarization

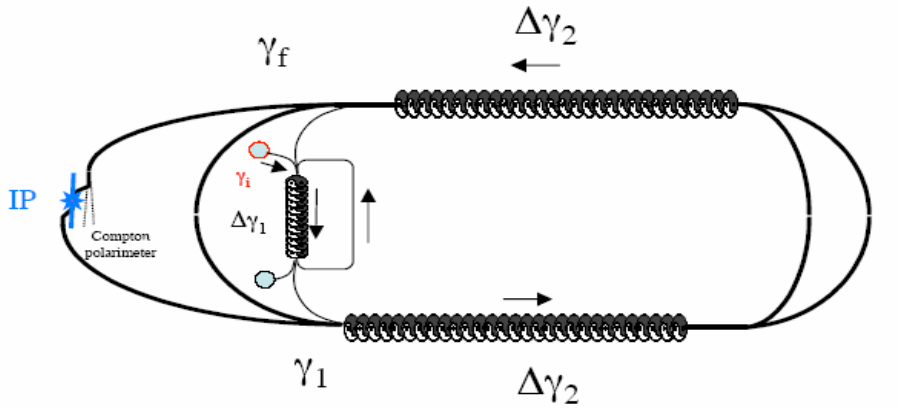
- Clear advantages of linac-ring option:
  - No multiturn circulation -> no depolarizing resonances -> all electron beam energies can be used
  - High polarization (as produced by polarized source). No polarization loss during acceleration.
  - No need for spin rotators to produce longitudinal polarization.

    In fact any polarization direction at the IP can be arranged.

Polarization transparency

Polarization transparency (from the source to the IP) is realized by synchronous small (<40MeV) adjustment of energy gains ($\Delta\gamma_1$, $\Delta\gamma_2$) in small and large linacs.

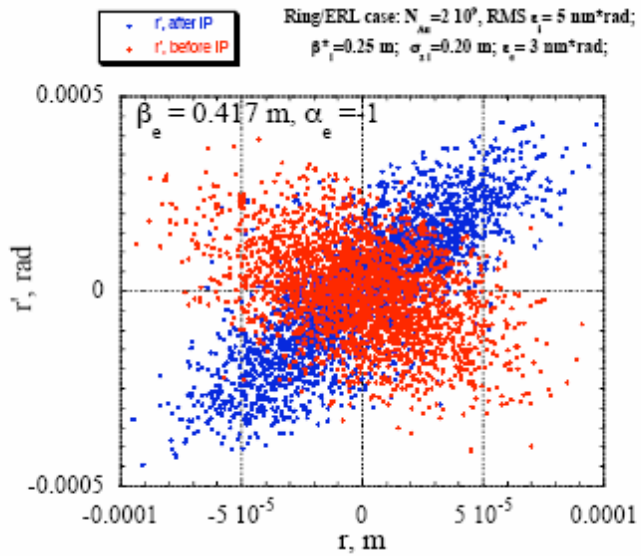




Spin direction in the IP:

$$\varphi = a\sum \Delta\theta_k\gamma_k = \pi a\{(6-1/12)\gamma_i + 10\Delta\gamma_1 + 8\Delta\gamma_2\}$$

Beam-beam. Electron emittance increase.



One pass beam-beam effects are characterized by disruption parameter:

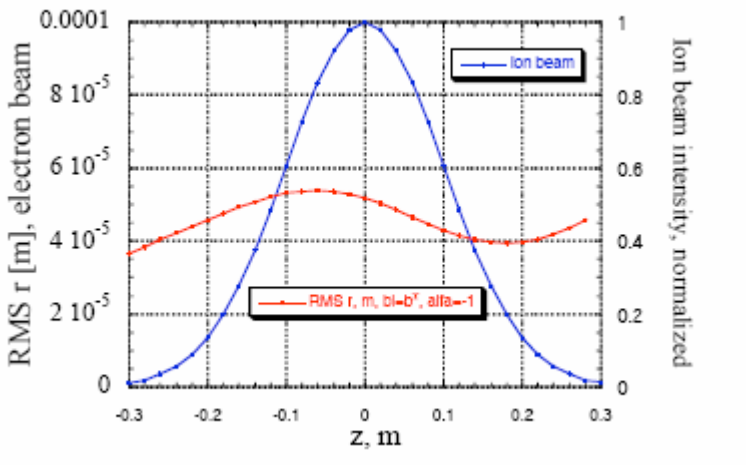
$$D = \frac{ZN_h}{\gamma_e}\frac{r_e}{\sigma_{r(h)}^2}\sigma_{s(h)} \sim 2\pi$$

Emittance increase < 20%,

no problem for further recirculation in the ERL

Electron beam phase space distribution plot before and after collision point.
Simulation done for D=3.6
Observed emittance increase ~11%

Beam-beam. Electron beam size modulation.



- Modulation of the size of electron beam during the collision.

  Without proper matching reduced electron beam size can increase hadron beam-beam parameter.

Simulation with D=3.6
Modest variation of electron beam size when the beam sizes matched at z=-0.3m

Kink head-tail instability

- Transverse instability of hadron beam (head and tail interaction through electron beam).

$$\Lambda = \frac{D\,\xi_h}{Q_s} < 2\pi$$

stability criteria is satisfied not for all modes of the eRHIC operation.
(10 Gev electrons in dedicated mode).

- Feedback system could be developed.
- More studies are planned on the subject (including nonlinear beam-beam force and linac jitter effects).

Electron multibunch instability

- Beam break-up through interaction with HOMs of SRF cavities.
- Discussed in Ilan's talk.
- The threshold current is higher than required for eRHIC.

Summary

- Electron beam polarization: no depolarizing effect, easy spin direction control at the IP.
- Beam-beam effects do not lead yet to serious degradation of electron beam.
- More studies are planned to evaluate kink head-tail instability of proton beam.